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IMPROVING FATTY ACID BALANCE IN EDIBLE OILS: A COMPARATIVE STUDY OF SUNFLOWER, RICE BRAN, AND THEIR BLENDS

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ABSTRACT

Cold-pressed oils have recently gained consumer interest due to their perceived nutritional benefits, while blended edible oils are increasingly marketed for offering complementary fatty acid profiles. The present study evaluated the fatty acid composition of sunflower and rice bran oils in their refined, cold-pressed, and blended forms. Fatty acid methyl esters (FAME) were analyzed using GC-FID. Results revealed that refining had no significant impact on individual fatty acid proportions in either oil. Rice bran oil exhibited the highest saturated fatty acid (SFA) content (23.60 ± 0.21%), while sunflower oil contained the lowest (7.84 ± 0.035%). Palmitic acid (C16:0) was the predominant SFA across all oils. Monounsaturated fatty acids (MUFA) were highest in the blended oil (44.13 ± 0.015%), whereas sunflower oil showed the highest polyunsaturated fatty acids (PUFA) (56.40 ± 0.071%). Sunflower oil contained the highest omega-6 content (C18:2n6cis), while rice bran oil contained more omega-3 fatty acids (C18:3n3cis). Blending rice bran oil with 20% sunflower oil improved the overall unsaturated-to-saturated fatty acid ratio from 11.76 to 3.64. These results suggest that blending sunflower and rice bran oils enhances their nutritional balance without altering core fatty acid composition due to extraction or refining.

Keywords **:** fatty acids, sunflower oil, rice bran oil, cold-pressed oil, blended oil, GC-FID.

Introduction

Edible oils are fundamental components of the human diet, serving as sources of energy, essential fatty acids, and lipid-soluble vitamins. Their nutritional value is largely determined by fatty acid composition, degree of unsaturation, antioxidant content, and oxidative stability (Choudhary *et al*., 2015). According to the World Health Organization (WHO), the recommended dietary ratio of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) is approximately 1 : 1.5 : 1, and the omega-3 to omega-6 fatty acid ratio should lie between 1 : 5 to 1 : 10 to minimize the risk of chronic diseases (WHO, 2008).

Sunflower (*Helianthus annuus*) oil is one of the most widely consumed edible oils globally. It is especially valued for its high PUFA content, dominated by linoleic acid (C18:2n6) and varying amounts of oleic acid depending on the cultivar (Akkaya, 2018). Its light flavour, oxidative stability, and favourable essential fatty acid composition make it a preferred household cooking oil in many countries.

Rice bran oil, extracted from the bran fraction of *Oryza sativa*, is increasingly recognized for its unique array of bioactive compounds such as γ-oryzanol, tocopherols, tocotrienols, and phytosterols (Latha & Nasirullah, 2014). Besides these antioxidants, rice bran oil contains a relatively higher SFA proportion than sunflower oil, along with substantial MUFA content, making it suitable for high-temperature cooking. India is among the world's largest producers and consumers of rice bran oil due to abundant rice production.

Extraction and processing play a significant role in determining the chemical composition and

nutritional quality of edible oils. Cold-pressed oils, obtained through mechanical pressing without high heat or chemical solvents, retain higher levels of natural antioxidants, minor bioactives (Rosenthal *et al*., 1996; Ramadan, 2013). Refined oils, on the other hand, undergo degumming, neutralization, bleaching, and deodorization to remove impurities. Although refinement improves clarity, odour, and shelf life, evidence suggests that fatty acid composition generally remains unaffected (Awogbemi *et al*., 2019; Pal *et al*., 2015).

Blending edible oils has emerged as a scientifically validated approach to improve fatty acid balance, enhance oxidative stability, and optimize nutritional attributes (Azadmard-Damirchi, 2010; Choudhary *et al*., 2015). Since no single oil provides all essential fatty acids or meets ideal SFA:MUFA:PUFA ratios, blending two or more oils creates a more balanced profile (Johnson *et al*., 2009). FSSAI regulations permit blending of two edible oils provided each contributes at least 20% by weight, ensuring product integrity and preventing adulteration.

Recent studies have demonstrated that appropriately blended oils can improve lipid profiles, reduce inflammation, and lower the risk of cardiovascular disease (Chandrashekar *et al.,* 2010; Jan *et al*., 2016). Given the growing consumer preference for cold-pressed and blended oils in India and globally, it becomes crucial to assess whether extraction method (cold-pressed vs. refined) and blending significantly alter fatty acid composition.

The present study investigates the fatty acid profiles of sunflower and rice bran oils in cold-pressed, refined, and commercially blended forms. It aims to determine whether processing affects fatty acid makeup and to evaluate how blending contributes to achieving a nutritionally balanced oil.

Materials and Methods

Sample Collection: Cold-pressed and refined sunflower oil (n = 4) and rice bran oil (n = 4) were procured from local markets in Hyderabad. Commercial blended oils (rice bran: sunflower at 80: 20) from four brands were also collected.

Preparation of fatty acid methyl esters: Fatty acid methyl esters from the oil samples was prepared by following procedure given by Ostermann *et al*., 2014 method. 18.00g of KOH was weighed and added to 10ml of water, then diluted with methanol to 500ml, and allowed to stand for 24hours, and filtered into a polyethylene bottle. 50mg of oil was reconstituted in 1ml of 0.5M methonolic KOH and hydrolyzed at 80°C for 1 hour in a water bath. 1ml of fresh 10% BF3 in methanol was added and *trans* esterification was performed at 100°C for 20minutes in a water bath. After trans esterification, 2ml distilled water and 1ml hexane were added to the sample to quench the reaction. The organic phase was recovered by pipetting out the upper layer, pooled and spiked with the methyl ester.

Determination of FA composition

Fatty acids were estimated by using gas chromatograph (7890B of Agilent technologies) equipped with Flame ionization detector and – DBFFAP column (Nitro terephthalic-acid-modified polyethylene glycol (PEG) of high polarity for the analysis of volatile fatty acids with the length 30m X 250 µm, diameter 0.25mm, film thickness of 0.25µm. The carrier gas was nitrogen at a flow rate of 30 ml/min while 1 µl of sample was injected in split injection mode at column oven temperature and injection temperature of 40°C and 260°C, respectively. EZ Total Chrome software was used for running the GC and calculation of fatty acid composition. FID Hydrogen gas flow rate was 30 ml/min. Zero air flow was 300 ml/min and make up flow was 25 ml/min. The fatty acid content was measured based on area normalization.

Standards used: Standard used was *47885-U* Supelco® 37 Component FAME Mix, 10 mg/mL in methylene chloride, analytical standard. 37-FAME standard was injected and the retention times were compared under standard conditions described above to ascertain that the individual standard peaks were coinciding exactly with the peaks in the combined standard. Samples were processed as described and injected as for standards. Sample fatty acid composition was compared with standard fatty acid composition and percentages calculated by normalization of peak areas.

Peroxide value (PV): Determined following the iodometric titration method (AOCS Cd 8-53). Approximately 2.0 g of oil was dissolved in 30 ml of an acetic acid–chloroform mixture (3:2, v/v). After adding 1 ml saturated KI and keeping the mixture in the dark for 1 min, 30 ml of distilled water was added, and the liberated iodine was titrated with 0.01 N $Na_2S_2O_3$ using starch as an indicator. A reagent blank was run simultaneously. PV was calculated as:

$$\mathrm{PV}\left(\mathrm{meq\,O_2\,/\,Kg}\right)=\frac{\left(\mathrm{V}-\mathrm{V_b}\right)\mathrm{N}\times 1000}{\mathrm{m}}$$

where V = sample titre (mL), V_b = blank titre (mL), N = normality of $Na_2S_2O_3$, and m = mass of sample (g).

Results were expressed as milliequivalents of active oxygen per kilogram of oil (meq O_2/kg).

Statistical Analysis: Data were analyzed in triplicate and expressed as mean ± SD. Significant differences were determined using one-way ANOVA ($p < 0.05$).

Results and Discussion

The fatty acid composition of cold-pressed, refined, and blended oils of sunflower and rice bran was analyzed using GC-FID, and the results are summarized in Table 1. Overall, the oils exhibited characteristic fatty acid profiles typical of their botanical origin, with variations primarily in the proportions rather than the presence or absence of individual fatty acids. The results also indicate that the refining process did not significantly alter the fatty acid composition of either sunflower or rice bran oil. This aligns with earlier studies reporting that refining removes impurities and minor compounds without modifying the triglyceride structure or the major fatty acids (Pal *et al*., 2015).

Sunflower oil showed a distinctly high proportion of polyunsaturated fatty acids (PUFA), particularly linoleic acid (C18:2n6), which accounted for 56.18–55.28% of total fatty acids. This high PUFA content confirms the well-documented nutritional profile of sunflower oil and its suitability for dietary purposes where essential fatty acids are required in larger quantities. Cold-pressed sunflower oil contained slightly lower PUFA and marginally higher saturated fat than refined sunflower oil; however, the differences were not statistically significant. Refining reduced the saturated fatty acid (SFA) content from 10.85% in cold-pressed to 7.84% in refined sunflower oil, but the overall fatty acid profile remained consistent. The monounsaturated fatty acid (MUFA) content ranged between 33.72% and 35.77%, dominated by oleic acid (C18:1n9) (Fig 1), which is known for its cardiovascular benefits.

Rice bran oil, in contrast, exhibited a higher SFA fraction, ranging from 23.60% to 23.63%, mainly due to its high palmitic acid (C16:0) content (20.18–20.39%). This is consistent with earlier reports characterizing rice bran oil as moderately saturated with considerable MUFA and PUFA proportions (Latha & Nasirullah, 2014). The MUFA content in rice bran oil was significantly higher than in sunflower oil, with oleic acid contributing around 40–41%. Additionally, rice bran oil had a slightly higher α-linolenic acid (C18:3n3cis) content (1.54–1.57%) compared to sunflower oil (0.16–0.23%), highlighting its potential contribution to omega-3 intake in blended products. The PUFA content of rice bran oil (34–35%) was substantially lower than that of sunflower oil, reflecting their complementary nutritional profiles.

Table 1: Fatty acid composition of sunflower, rice Bran, and multisource edible oils

	Sunflower Oil		**Rice bran Oil**		**Multisource Oil (Rice bran: Sunflower)**
	Cold Pressed	**Refined**	**Cold Pressed**	**Refined**	**Refined**
Caprylic Acid (C8: 0)	--	--	--	--	--
Capric Acid (C10: 0)	--	--	--	--	--
Lauric Acid (C12:0)	--	--	--	--	--
Myristic Acid (C14:0)	0.05±0.007	0.07±0.007	0.32±0.035	0.33±0.014	0.33±0.015
Palmitic Acid (C16:0)	5.52±0.021	5.73±0.021	20.39±0.212	20.18±0.085	19.16±0.025
Stearic Acid (C18:0)	4.05±0.021	1.50±0.049	1.74±0.247	1.93±0.021	0.75±0.030
Arachidic Acid (C20:0)	0.19±0.014	0.25±0.021	0.77±0.035	0.77±0.028	0.63±0.015
Behenic Acid C22:0)	1.05±0.014	0.31±0.021	0.22±0.014	0.24±0.014	0.57±0.015
Lignoceric Acid (C24:0)	--	-- --	0.20±0.014	0.22±0.014	0.14±0.006
SFA	**10.85± 0.007**	**7.84±0.035**	**23.63±0.134**	**23.60±0.212**	**21.56±0.03**
Palmitoleic acid (C16:1)	0.07±0.007	0.07±0.014	0.22±0.042	0.19±0.007	0.18±0.006
Oleic Acid (C18:1n9cis)	33.15±0.000	34.56±0.049	40.96±0.092	40.55±0.141	39.73±0.055
Cis-11-Eicosenoic Acid (C20:1n9)	--	--	0.59±0.064	0.48±0.085	0.03±0.006
Erucic Acid (C22:1n9)	--	--	--	--	--
Nervoinic Acid (C24:1n9)	0.51±0.007	1.15±0.021	--	--	1.2±0.0450
MUFA	**33.72± 0.014**	**35.77±0.042**	**41.76±0.198**	**41.22±0.219**	**41.14±0.015**
Linoleic Acid (C18:2n6cis)	55.28± 0.000	56.18±0.092	33.05±0.148	33.13±0.035	36.64±0.060
α-Linolenic acid (18:3)	0.16±0.007	0.23±0.021	1.57±0.078	1.54±0.042	0.65±0.035
Cis-11-14-Eicosadinoic Acid (C20:2)	--	--	0.04±0.014	0.53± 0.014	0.05±0.006
PUFA	**55.44±0.007**	**56.40±0.071**	**34.65±0.057**	**35.20±0.007**	**37.34± 0.021**

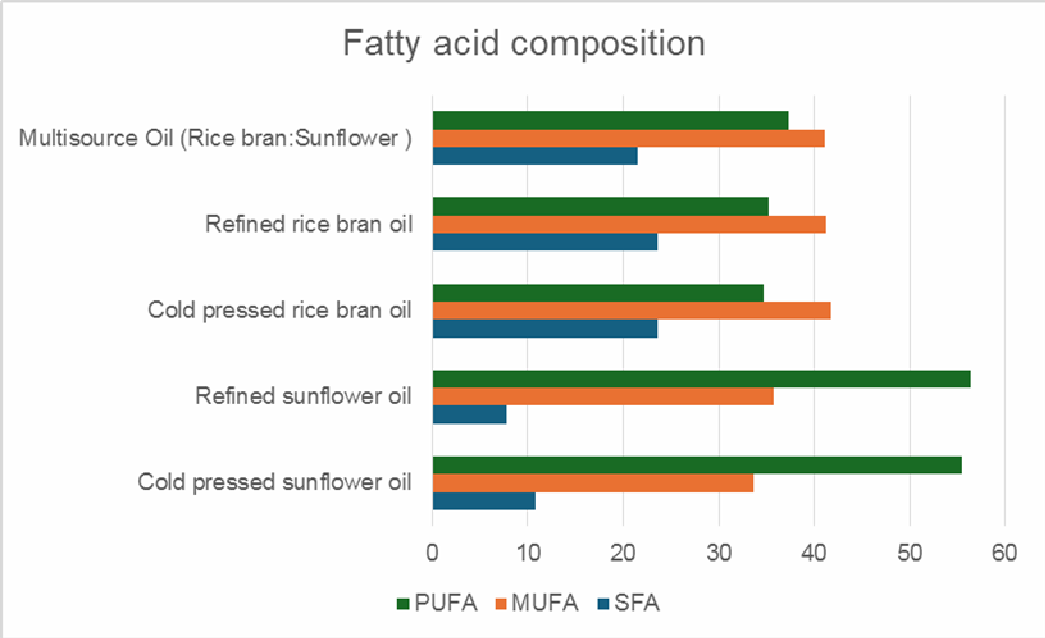

Fig. 1 : Comparative fatty acid profile of sunflower, rice bran, and blended edible oils

The commercially blended oil (80:20 Ricebran: Sunflower) exhibited an intermediate fatty acid composition relative to its parent oils. The SFA content (21.56%) was closer to that of rice bran oil due to its higher proportion in the blend, while MUFA levels were highest in the blended oil (41.14%), indicating that blending effectively enhanced oleic acid content beyond that of either oil alone. This synergistic improvement in MUFA levels is important because MUFA-rich diets have consistently been linked to improved lipid profiles, reduced inflammation, and better oxidative stability of oils during cooking (Johnson et al., 2009; Jan et al., 2016). The PUFA content of the blended oil (37.34%) reflected the expected contribution from sunflower oil, ensuring a balanced inclusion of essential fatty acids.

An important outcome of blending was the improvement in the unsaturated-to-saturated fatty acid (U/S) ratio. While sunflower oil exhibited an extremely high U/S ratio of 11.76 due to its abundant PUFA, rice bran oil had a lower U/S ratio owing to its higher SFA content. The blended oil demonstrated a more balanced U/S ratio of 3.64, which is nutritionally more favourable and closer to WHO recommendations for dietary fat intake. This finding supports existing literature that blending edible oils is an effective strategy to optimize fatty acid balance and improve the nutritional profile without compromising functionality (Choudhary *et al.,* 2015).

Another noteworthy observation is that the refining process did not significantly influence the composition of individual fatty acids in either sunflower or rice bran oils. The minimal differences observed in cold-pressed versus refined oils were largely attributable to natural variability rather than processing effects. These results reinforce earlier findings that major fatty acids remain stable during refining, while minor bioactive compounds may undergo changes (Azadmard-Damirchi *et al*., 2010; Pal *et al*., 2015). Thus, consumers preferring cold-pressed oils for nutritional reasons may gain additional phytochemicals, but not a significantly different fatty acid profile.

Table 2: Peroxide values of cold-pressed and refined sunflower oil, rice bran oil and their blend

Oil Type	Processing	Peroxide Value (meq O_2/kg) ± SEM
Sunflower Oil	Cold-Pressed	4.8 ± 0.22
Sunflower Oil	Refined	2.1 ± 0.11
Rice Bran Oil	Cold-Pressed	3.6 ± 0.18
Rice Bran Oil	Refined	1.4 ± 0.07
Multisource Oil (Rice Bran+ Sunflower)	Refined	1.9 ± 0.09

The peroxide values (PV) of cold-pressed and refined edible oils showed significant variation, reflecting the influence of processing methods on oxidative stability (Table 2). Among the oils tested, cold-pressed sunflower oil recorded the highest PV (4.8 ± 0.22 meq O_2/kg), followed by cold-pressed rice bran oil (3.6 ± 0.18 meq O_2/kg). In contrast, their refined counterparts exhibited substantially lower peroxide values 2.1 ± 0.11 meq O_2/kg for refined sunflower oil and 1.4 ± 0.07 meq O_2/kg for refined rice bran oil. The multisource blended oil (rice bran + sunflower) also showed a comparatively low PV (1.9 ± 0.09 meq O_2/kg), indicating improved oxidative stability due to blending and refining.

The higher PVs observed in cold-pressed oils can be attributed to the presence of natural pro-oxidants, residual moisture, enzymes, pigments, and seed particulates, which accelerate primary lipid oxidation. Because cold pressing avoids high-temperature deodorization, lipoxygenase and hydroperoxidase enzymes may remain active, contributing to faster hydroperoxide formation. Similar trends have been reported by Pandurangan *et al*., 2014 and Ghazani & Marangoni, 2013, who noted that minimal processing increases susceptibility to oxidation in unrefined oils.

On the other hand, refined oils consistently exhibited lower peroxide values, which may be linked to the removal of phospholipids, free fatty acids, metal ions, and other pro-oxidants during degumming, neutralization, bleaching, and deodorization. Deodorization at high temperature (220–240°C) destroys hydroperoxides and inactivates oxidative enzymes, thereby improving stability. Previous studies by Naz *et al*., 2004 and Choe & Min, 2006 confirmed that refining reduces oxidative substrates and hydroperoxides, leading to lower PV in refined oils.

The multisource refined oil showed peroxide values intermediate to refined single-source oils. This may be attributed to the antioxidant components of rice bran oil (such as γ-oryzanol and tocotrienols) and the oxidative stability of the sunflower-rice bran blend, as reported by Zou *et al*., 2022. Blending also dilutes the more oxidation-prone polyunsaturated fatty acids (PUFAs) of sunflower oil, improving resistance to primary oxidation.

Although cold-pressed oils exhibited higher peroxide values compared to refined oils, this sensitivity reflects their natural composition rather than inferior quality. Peroxide value proved to be a sensitive indicator of early oxidative changes and can be effectively managed through appropriate storage conditions such as amber containers, limited oxygen exposure, and cool temperatures. Sunflower oil contributed a high proportion of polyunsaturated fatty acids, while rice bran oil enhanced the profile with higher monounsaturated and omega-3 fatty acids. Blending these cold-pressed oils resulted in a more balanced and nutritionally desirable fatty acid composition. Such blends successfully combine the health benefits of cold-pressed oils with improved functional performance. Overall, cold-pressed sunflower and rice bran oil blends represent a health-oriented and scientifically justified alternative to refined oils.

References

American Oil Chemists' Society (2017). Official method Cd 8-53. *Official methods and recommended practices of the AOCS*, 7th edn. AOCS Press.

Akkaya, M.R. (2018). Prediction of fatty acid composition of sunflower seeds by near-infrared reflectance spectroscopy. *J Food Sci Technol* 55(6): 2318–2325.

Awogbemi, O., Onuh, E.I. and Inambao, F.L. (2019). Comparative study of properties and fatty acid composition of some neat vegetable oils and waste cooking oils. *Int J Low-Carbon Technol* **14**(3): 417–425.

Azadmarddamirchi, S. (2010). Review of the use of phytosterols as a detection tool for adulteration of olive oil with hazelnut oil. *Food Addit Contam* **27**(1): 1–10.

Chandrashekar, P., Lokesh, B.R. and Krishna, A.G. (2010). Hypolipidemic effect of blends of coconut oil with soybean oil or sunflower oil in experimental rats. *Food Chem* **123**(3): 728–733.

Choe, E. and Min, D.B. (2006). Mechanisms and factors for edible oil oxidation. *Compr Rev Food Sci Food Saf* **5**: 169–186.

Choudhary, M., Grover, K. and Kaur, G. (2015). Development of rice bran oil blends for quality improvement. *Food Chem* **173**: 770–777.

Ghazani, S.M. and Marangoni, A.G. (2013). Minor components in canola oil and effects of refining on these constituents: A review. *J Am Oil Chem Soc* **90**(7): 923–932.

Jan, K.C., Huang, M.Y., Chang, C.J. and Liu, T.C. (2016). Hypolipidemic effect of blended oil in hamster: biochemical analysis and gene expression profiling. *J Food Nutr Res* **4**: 26–32.

Johnson, S., Saikia, N., Mathur, H.B. and Agarwal, H.C. (2009). Fatty acids profile of edible oils and fats in India. *Centre for Science and Environment*, New Delhi, pp. 1–42.

Latha, R.B. and Nasirullah, D.R. (2014). Physico-chemical changes in rice bran oil during heating at frying temperature. *J Food Sci Technol* **51**(2): 335–340.

Naz, S., Sheikh, H., Siddiqi, R. and Sayeed, S.A. (2004). Oxidative stability of olive, corn and soybean oil under different conditions. *Food Chem* **88**: 253–259.

Ostermann, A.I., Müller, M., Willenberg, I. and Schebb, N.H. (2014). Determining the fatty acid composition in plasma and tissues as fatty acid methyl esters using gas chromatography – a comparison of different derivatization and extraction procedures. *Prostaglandins Leukot Essent Fatty Acids* **91**(6): 235–241.

Pal, U.S., Patra, R.K. and Sahoo, N.R. (2015). Effect of refining on quality and composition of sunflower oil. *J Food Sci Technol* **52**: 4613–4618.

Pandurangan, M.K., Murugesan, S. and Gajivaradhan, P. (2014). Physico-chemical properties of groundnut oil and their blends with other vegetable oils. *J Chem Pharm Res* **6**(8): 60–66.

Ramadan, M.F. (2013). Healthy blends of high linoleic sunflower oil with selected cold pressed oils: functionality, stability and antioxidative characteristics. *Ind Crops Prod* **43**: 65–72.

Rosenthal, A., Pyle, D.L. and Niranjan, K. (1996). Aqueous and enzymatic processes for edible oil extraction. *Enzyme Microb Technol* **19**: 402–420.

World Health Organization. (2008). *Global strategy on diet, physical activity and health*. Geneva: World Health Organization.

Zou, M., Chen, Y., Hu, C., He, D. and Gao, P. (2022). Physicochemical properties of rice bran blended oil in deep frying by principal component analysis. *J Food Sci Technol* **59**(11): 4187–4197.